Project: **970**

Project title: **TARANTO**

Project members: **Uwe Mikolajewicz, Katharina Six, Feifei Liu (MPI-Met), Gerhard Schmiedl, and Kay Emeis (CEN, Uni HH)**

Allocation period: **1.1.2016 - 31.12.2016**

The aim of our project is to reconstruct records of climate and related biogeochemical cycles in the Gulf of Taranto (southern Italy) for the past few centuries and the late Holocene. To achieve this goal, we will derive a novel spatio-temporal transfer function that defines the relationships between proxy data and environmental parameters both in the spatial and temporal domain from model simulations. We will combine proxy records (CEN, Uni HH) with an advanced physical/biogeochemical model (MPI-Met).

The project started in May 1st. In the last six months, we have set up the ocean circulation and biogeochemistry model (MPIOM-HAMOCC) for the Mediterranean Sea and the Black Sea with the horizontal resolution of approx. 9km and 30 layers in the vertical. We adapted the model to reproduce a realistic climate if forced by the 3-hourly ERA-20C atmospheric data (ECMWF's first atmospheric reanalysis of the 20th century: 1901-2010, Poli et al. 2013). As a first step river input (river discharge and nutrient load) were taken from the Realistic Hydrology Model Run (Global NEWS 2) corresponding to the state of year 2000 (Mayorga et al, 2010). The sediment module has also been adapted to allow the recording of sediment variations with a high spatio-temporal resolution (vertically 14 levels).

The model has been tuned to adjust to the Mediterranean system and has been spun up for 330 years. Fig. 1 shows the sea surface salinity after 330 years' spin up (restoring restricted to the Atlantic margin, no restoring inside Mediterranean and Black Sea) in comparison with the MedAtlas Climatology. The model results show a good agreement with the observations. The Adriatic, however, is too fresh.

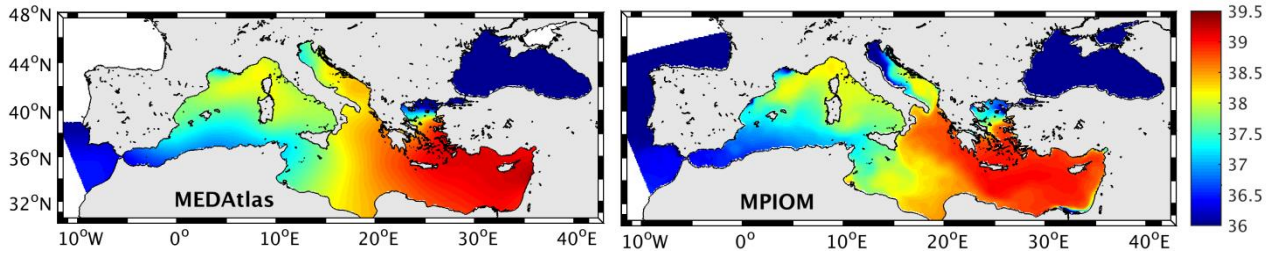


Fig.1 The climatic sea surface salinity obtained from the Mediterranean Atlas (left) and from the model simulation averaged over 1980 to 1989 (right). Unit: psu.

Fig.2 shows the spatial pattern of the vertically integrated primary production averaged over the ERA-20C period, which is characterized by the highest production in the Black Sea and the lowest in the eastern Mediterranean Sea. The simulated distribution shows similar patterns as the satellite observations as shown in Bosc et al. (2004).

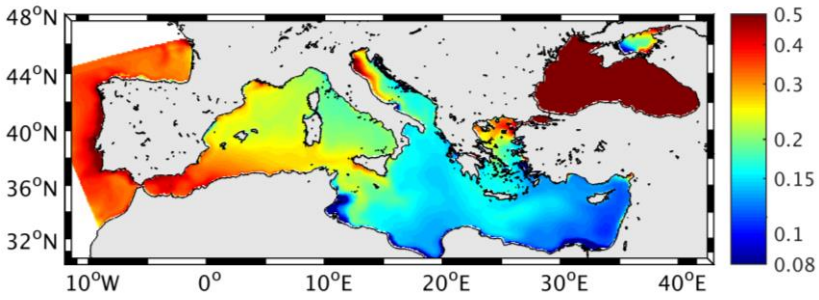


Fig.2 Vertically integrated primary production averaged over 1900-2010. Unit: g C $m^{-2}$ $d^{-1}$

In Fig.3 and Fig.4, time series of sea surface temperature (SST) and vertically integrated primary production in the Gulf of Taranto display substantial variability, both on interannual and on decadal time scales.

Comparison of the atmospheric forcing from ERA-20C with the corresponding NOAA-CIRES product 20CRv2c (NOAA-CIRES 20th Century Reanalysis version 2c: 1851-2010, Compo et al. 2011) reveals substantial differences between these data sets. As an example the time series of the precipitation integrated over the Adriatic Sea is shown in Fig. 5. It is obvious that the decadal variability in these two reanalysis data sets is only weakly correlated. Therefore we have started to run the model with the 20CRv2c atmospheric data set to obtain an additional independent estimate of the variability. The lower precipitation rates in20CRv2c are also expected to reduce the fresh bias in the Adriatic that appeared in the simulation forced with ERA-20C (see Fig. 1).

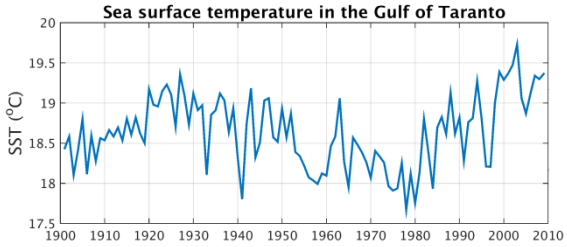


Fig.3 Time series of annual mean SST in the Gulf of Taranto from 1900 to2010 with ERA-20C forcing

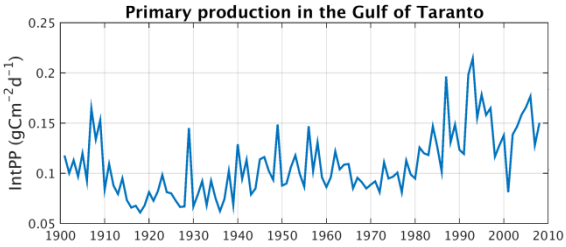


Fig.4 Time series of vertically integrated annual mean primary production in the Gulf of Taranto from 1900 to2010 with ERA-20C forcing

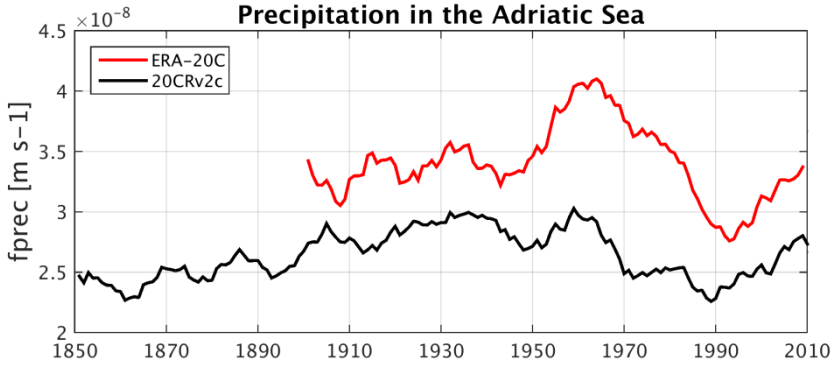


Fig.5 10-year running mean precipitation in the Adriatic Sea obtained from ERA-20C and 20CRv2c. The 20CRv2c covers a longer time interval and shows substantially differences to ERA-20C, e.g. in the precipitation, both for the mean and the decadal variability.

## References

Bosc, E., Bricaud, A. and Antoine, D., 2004. Seasonal and interannual variability in algal biomass and primary production in the Mediterranean Sea, as derived from 4 years of SeaWiFS observations. *Global Biogeochemical Cycles*, 18(1).

Compo, G.P., J.S. Whitaker, P.D. Sardeshmukh, N. Matsui, R.J. Allan, X. Yin, B.E. Gleaso n, R.S. Vose, G. Rutledge, P. Bessemoulin, S. Brönnimann, M. Brunet, R.I. Crouthamel, A.N . Grant, P.Y. Groisman, P.D. Jones, M. Kruk, A.C. Kruger, G.J. Marshall, M. Maugeri, H.Y . Mok, Ø. Nordli, T.F. Ross, R.M. Trigo, X.L. Wang, S.D. Woodruff, and S.J. Worley, 2011. The Twentieth Century Reanalysis Project. *Quarterly Journal of the Royal Meteorological Society*, 137: 1-28. DOI: 10.1002/qj.776

Mayorga, E., S.P. Seitzinger, J.A. Harrison, E. Dumont, A.H.W. Beusen, A.F. Bouwman, B.M. Fekete, C. Kroeze and G. Van Drecht. 2010. Global Nutrient Export from WaterSheds 2 (NEWS 2): Model development and implementation. *Environmental Modelling & Software.* 25: 837-853, doi:10.1016/j.envsoft.2010.01.007

Poli, P., Hersbach, H., Tan, D., Dee, D., Thepaut, J.N., Simmons, A., Peubey, C., Laloyaux, P., Komori, T., Berrisford, P. and Dragani, R., 2013. *The data assimilation system and initial performance evaluation of the ECMWF pilot reanalysis of the 20th-century assimilating surface observations only (ERA-20C)*.